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No. 3/1986

LEACHING OF TMAO AND VOLATILE NITROGEN COMPOUNDS FROM FISH STORED IN ICE

by

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1 INTRODUCTION

Water soluble compounds in fish leach into the melt water when fish is stored in ice and into the sea water when it is stored in RSW. Leaching during storage in sea water was studied in the project called "An analysis of the quality of fish stored in refrigerated sea water and in ice" (Tertnes et alt., 1982 - 1983). In order to study leaching when storing in ice, a series of experiments was set up where the melt water was collected.

2 MATERIAL AND METHODS

2.1 Test material

The test material was coalfish, 300 - 500 g, caught in April, 1983. Whole coalfish, blood-drained coalfish, and gutted and deheaded coalfish were used in the experiments.

2.2 Test conditions

The fish was stored in ordinary fish boxes with ice. There was one type per box. The boxes were kept in cold storage at +3 degrees C. One box with gutted and deheaded fish was also stored at about +25 degrees C.

Each box contained 20 kg of fish, and more ice was added when it was necessary. The melt water was collected in containers placed in ice. Samples were taken after 1, 3, 6, 9, 13, and 16 days and analyzed, and the container where the melt water had been collected was replaced.

2.3 Preparation of samples

Each fish was filleted and skinned. Skin, back-bone and, when applicable, head and entrails were collected in a counterbalanced homogenizer, and the weight was recorded. An equal amount of 10% tricloroacetic acid was added and homogenized. The homogenate was filtered. The fillets were then treated in the same manner. The waste matter was homogenized as soon as possible after filleting. The filtrate was used in the analyses.

The volume of melt water was measured. For the analyses, 9 parts water were mixed with 1 part 60% TCA solution and then filtered. (3)

2.4 Methods of analysis

Total content of volatile N and TMAO (trimethylaminoxide) was determined through microdiffusion (Conway and Byrne, 1933).

Trimethylamine (TMA) was determined colorimetrically with extraction at -15 degrees C, as described by Bullard and Collins (1980).

Dimethylamine (DMA) was determined colorimetrically (Dowden, 1938).

Hypoxanthine, inosine and inosinemonophosphate (IMP) was determined through high-performance liquid chromatography (HPLC). A 20 ml TCA extract was adjusted with 30% KOH to a pH of about 5 and diluted to 50 ml. Column RP-8, 25 x 4.6 mm. Particle diameter: 10 µm. Mobile phase: 85% 0.01 M KH_2PO_4, 8% MeOH, 7% H_2O, 1.2 ml/min. Ambient temperature.

Dry matter in melt water was determined through evaporation until dry at 105 degrees C.

Ninhydrin reactive substances were determined colorimetrically after reaction with ninhydrin. This series was used as reference.

3 RESULTS AND DISCUSSION

The fish that was kept in cold storage (about +3 degrees C) was covered with ice during the entire test period, while the fish that

was stored at ambient temperature, where the temperature reached 26 degrees C, had a sparse amount of ice after the week-end. The amount of melt water was the greatest from the box stored at room temperature. Of the samples in cold storage, the box with blood-drained fish (Table 1) had the least amount of melt water. This may be due to the fact that this box was placed between the boxes containing the other sample types, and it was thus more insulated along its sides than the boxes placed on the outside.

Table 1. Melt water volume

The table shows the amount of collected melt water. The fish was stored in ice at +3 degrees C and at +25 degrees C.

Days	Whole,+3 °C 1	Bled,+3 °C 2	Gutted,+3 °C 3	Gutted,+25 °C 4
1	1.2	2.0	3.5	7.0
3	3.2	3.7	5.5	18.5
6	5.94	6.05	8.62	35.23
9	8.37	8.61	12.64	59.09
13	17.73	12.47	17.78	92.12
16	20.95	15.51	22.21	119.11

The amount of dry matter in the melt water was determined and is shown in Table 2 in relation to the amount of fish in the boxes. From the boxes that were kept in cold storage, the highest amount of dry matter was leached from the fish from which only blood had been drained, a little less from fish that was gutted and de-headed, and the least amount from whole fish. This was most likely due to the blood from the drained fish. From the box with gutted fish that was stored at ambient temperature, more than 5 times more melt water was collected, than from the box with gutted fish that was kept in cold storage. However, just a little more than twice as much dry matter was leached during the course of the experiment.

Table 2. Leaching of dry matter.

The table shows the amount of dry matter found in melt water in relation to the amount of fish.

Days	Whole,+3 °C g/100g	Bled,+3 °C g/100g	Gutted,+3 °C g/100g	Gutted,+25 °C g/100g
1	0.03	0.10	0.07	0.11
3	0.07	0.15	0.13	0.23
6	0.12	0.21	0.22	0.39
9	0.18	0.66	0.35	0.72
13	0.31	0.81	0.66	1.42
16	0.44	0.96	0.83	1.74

The leaching of ninhydrin reactive compounds was the greatest in gutted fish and the least in whole fish (Table 3). We have not found any analyses of the composition of blood in fish, but it seems natural to assume that the above results are due to a higher content of free aminoacids in muscles as compared to

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blood. The relationship between the leaching of ninhydrin reactive compounds from fish stored in ice at ambient temperature and in cold storage is about the same as for leaching of dry matter.

Table 3. Leaching of ninhydrin reactive compounds.

The table shows the amount of ninhydrin reactive compounds found in the melt water in relation to the amount of fish. This series was used as a reference.

Days	Whole, +3 °C mg/100g	Bled, +3 °C mg/100g	Gutted, +3 °C mg/100g	Gutted, +25 °C mg/100g
1	1.2	6.2	5.1	8.0
3	4.9	11.7	12.2	23.1
6	11.2	18.2	24.2	40.7
9	21.3	39.8	46.2	81.9
13	43.2	55.6	78.8	179.1
16	64.9	79.4	97.0	244.9

The leaching of total volatile nitrogen, TMAO, TMA and DMA is shown in Figures 1-4. The leaching of TMAO appears to be much less than the leaching of TMA and DMA. This is most likely due to the situation that TMAO is converted into TMA and DMA, and the combined total of TMAO, TMA and DMA is therefore also shown.

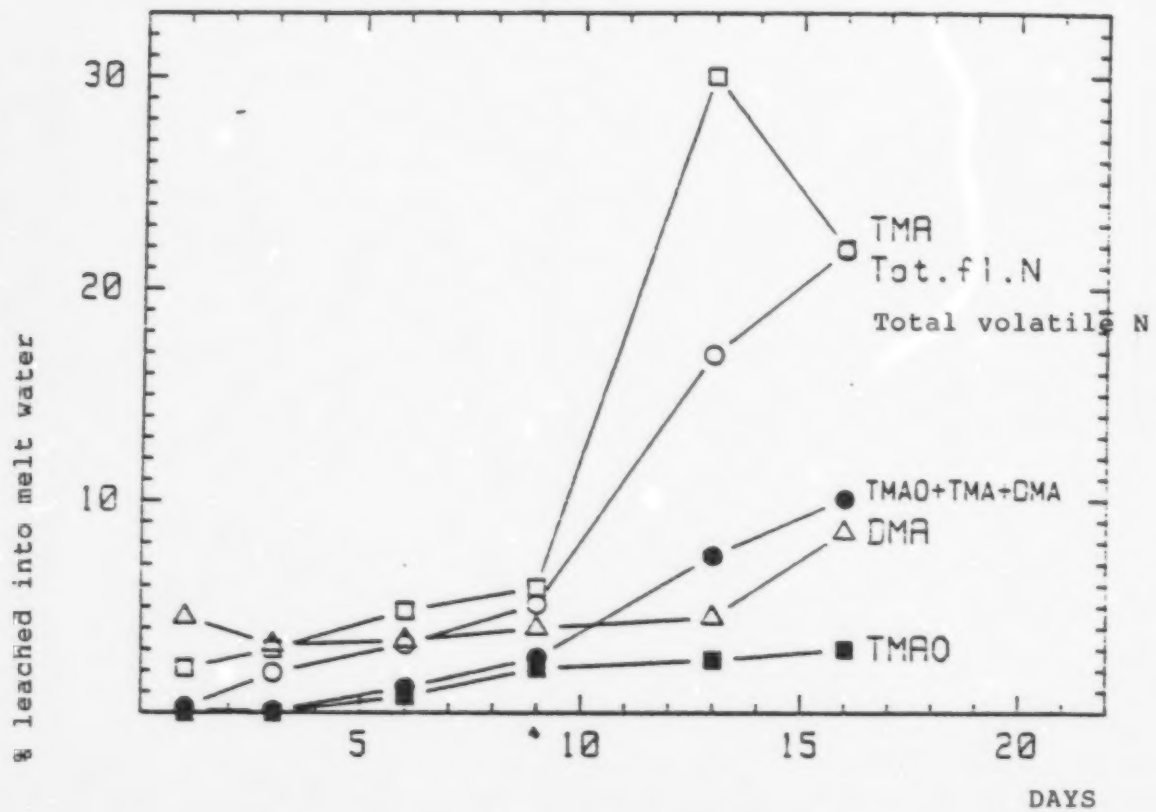

Fig. 1 Percentage of TMAO and volatile nitrogen compounds found in melt water from whole coalfish in ice, stored at +3 degrees C.

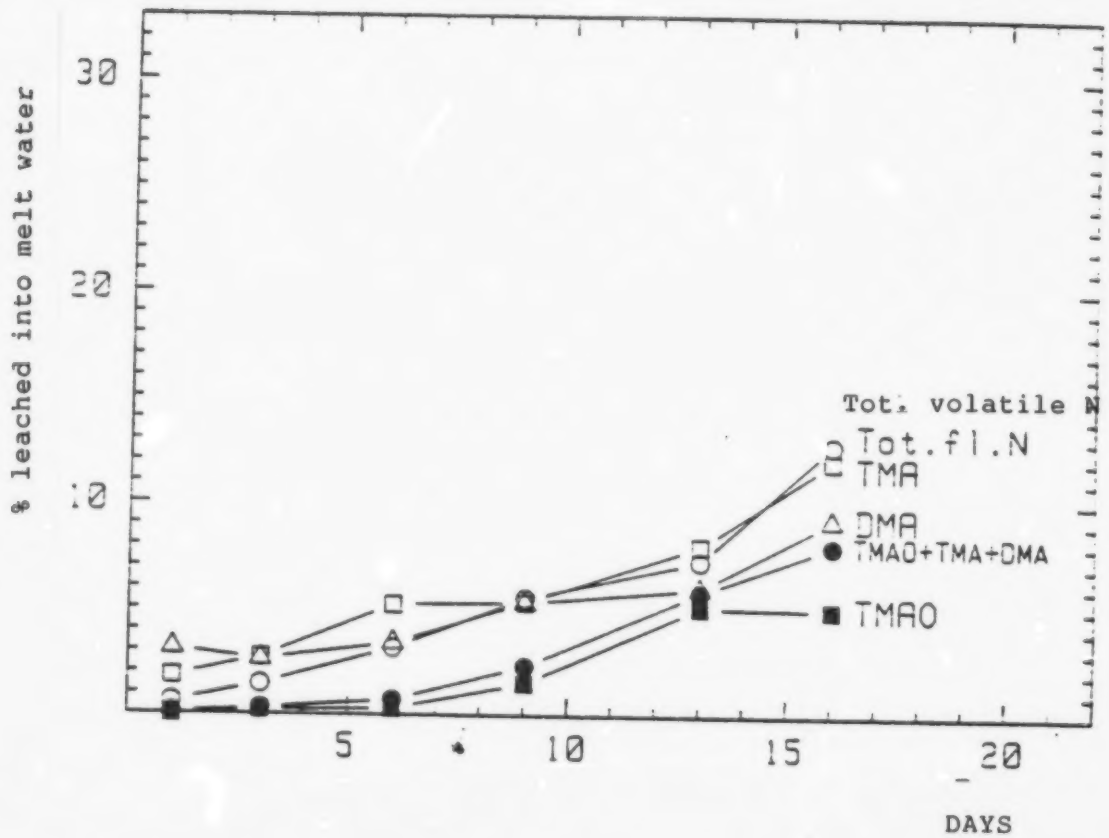

Fig. 2 Percentage of TMAO and volatile nitrogen compounds found in melt water from blood-drained coalfish, stored in ice at +3 degrees C.

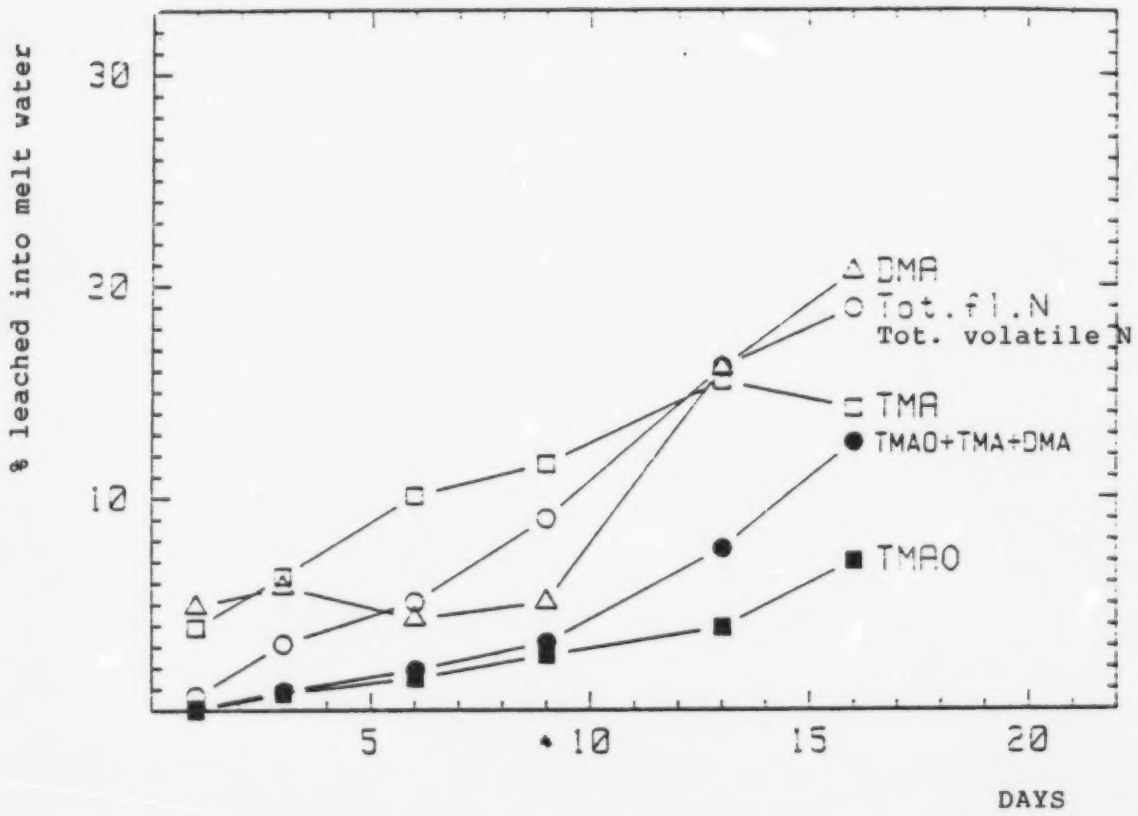

Fig. 3. Percentage of TMAO and volatile nitrogen compounds found in melt water from gutted and deheaded coalfish, stored in ice at +3 degrees C.

Among the samples that were kept in cold storage, the leaching of TMAO and degradation products was the highest for gutted fish (Fig. 3) and the lowest for blood-drained fish (Fig. 2).

However, the percentage of total volatile nitrogen found in the melt water, was the highest for whole fish (Fig. 1). The fact that the leaching of TMAO, DMA, TMA and total volatile nitrogen was the lowest for blood-drained fish, can be partly explained by the smaller volume of melt water (Table 1).

The leaching from fish stored at ambient temperature was more than 3 times greater than for fish kept in cold storage (Fig. 4).

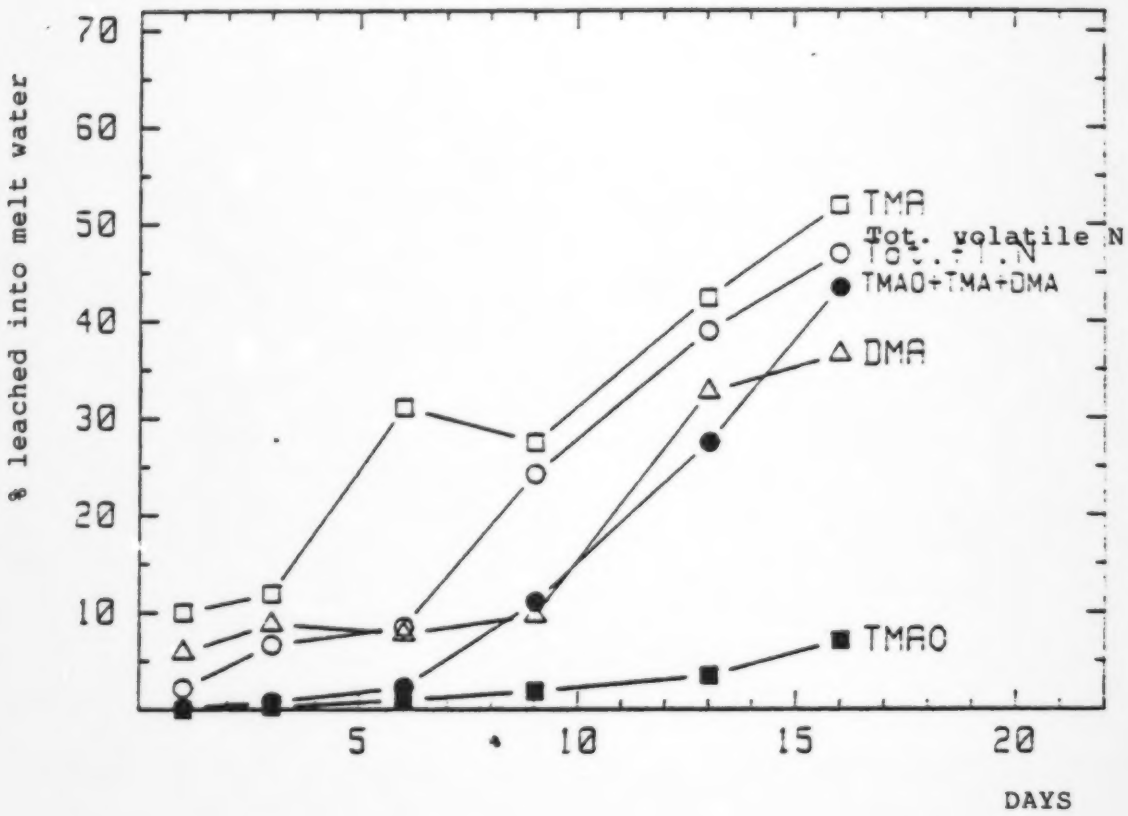

Fig. 4. Percentage of TMAO and volatile nitrogen compounds found in melt water from gutted and deheaded coalfish, stored at +25 degrees C.

Compared to coalfish stored in RSW (Tertnes et al., 1982-1983), the values obtained were lower for fish kept in cold storage, but higher for fish stored at ambient temperature.

The concentration of inosinemonophosphate, inosine and hypoxanthine in fish and melt water was also determined. No inosinemonophosphate was found in any of the samples with melt water from whole fish (Fig. 5). After 13 days, the leached amounts were the greatest for gutted fish (Fig. 7), while after 16 days, it was the blood-drained fish that had the highest amount of leached inosine (Fig. 6).

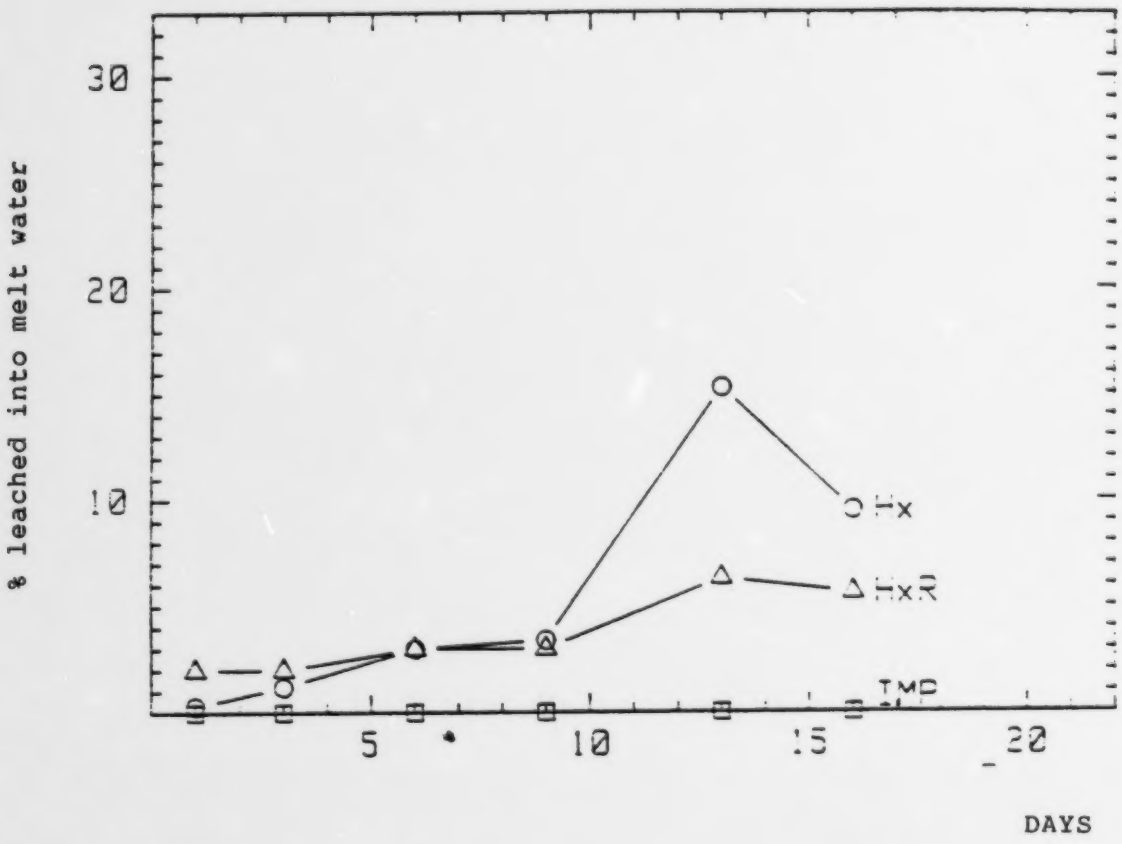

Fig. 5. Percentage of hypoxanthine, inosin and inosine-monophosphate found in melt water from whole coalfish, stored in ice at +3 degrees C.

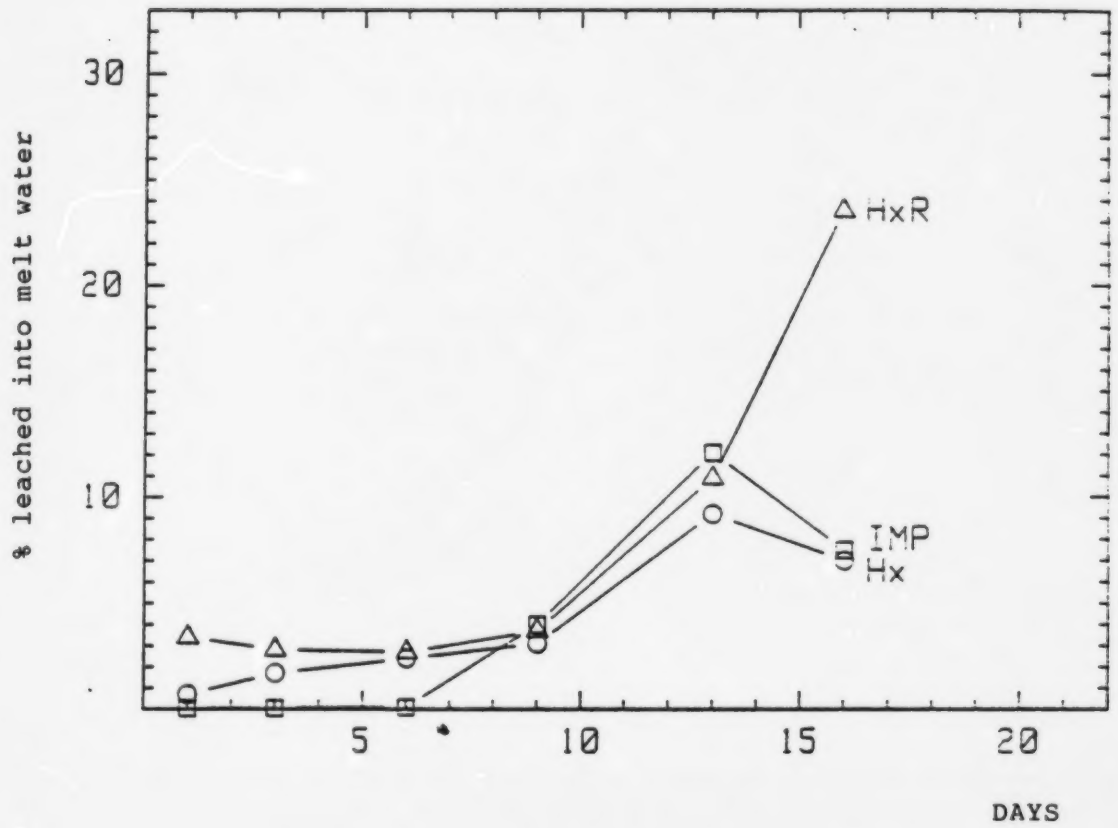

Fig. 6 Percentage of hypoxanthine, inosine and inosine-monophosphate found in melt water from blood-drained coalfish, stored in ice at +3 degrees C.

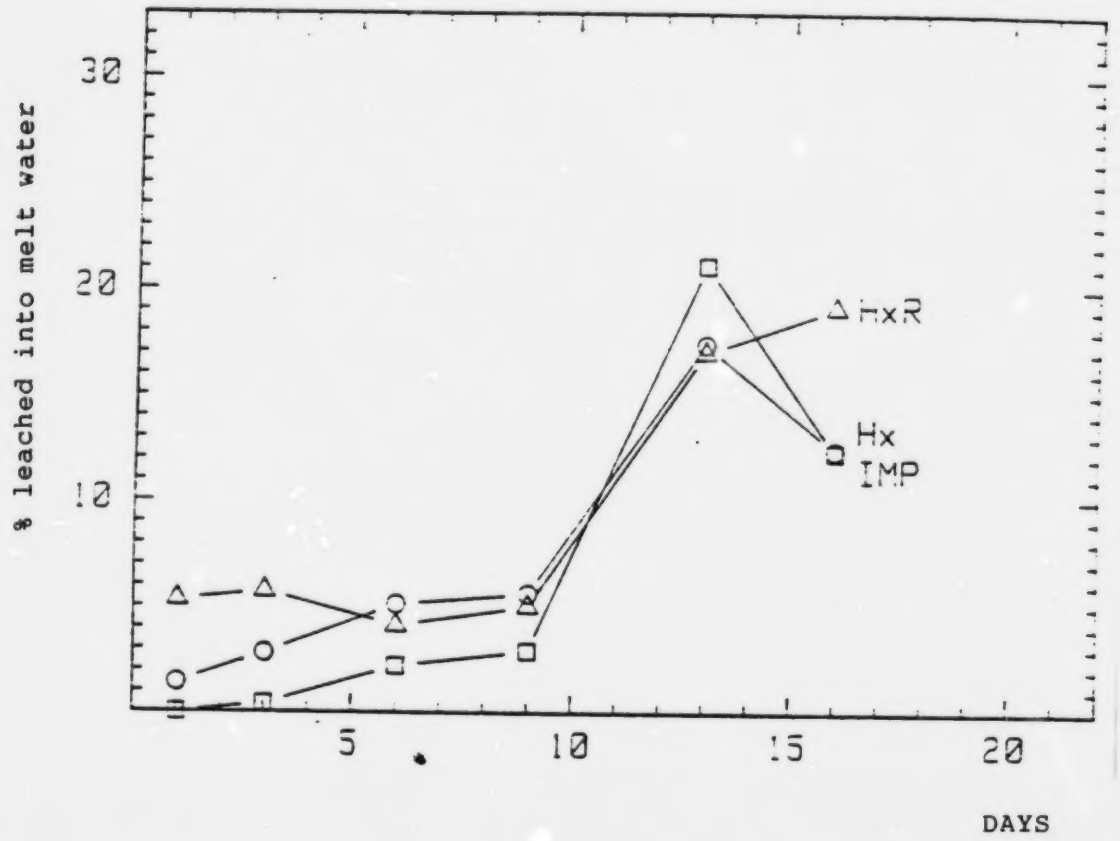

Fig. 7. Percentage of hypoxanthine, inosine and inosinemonophosphate found in melt water from gutted and deheaded coalfish, stored in ice at +3 degrees C

As expected, the highest values obtained were for fish stored at ambient temperature (Fig. 8). After 16 days, more the 60% of total inosinemonophosphate and inosine was found in the melt water.

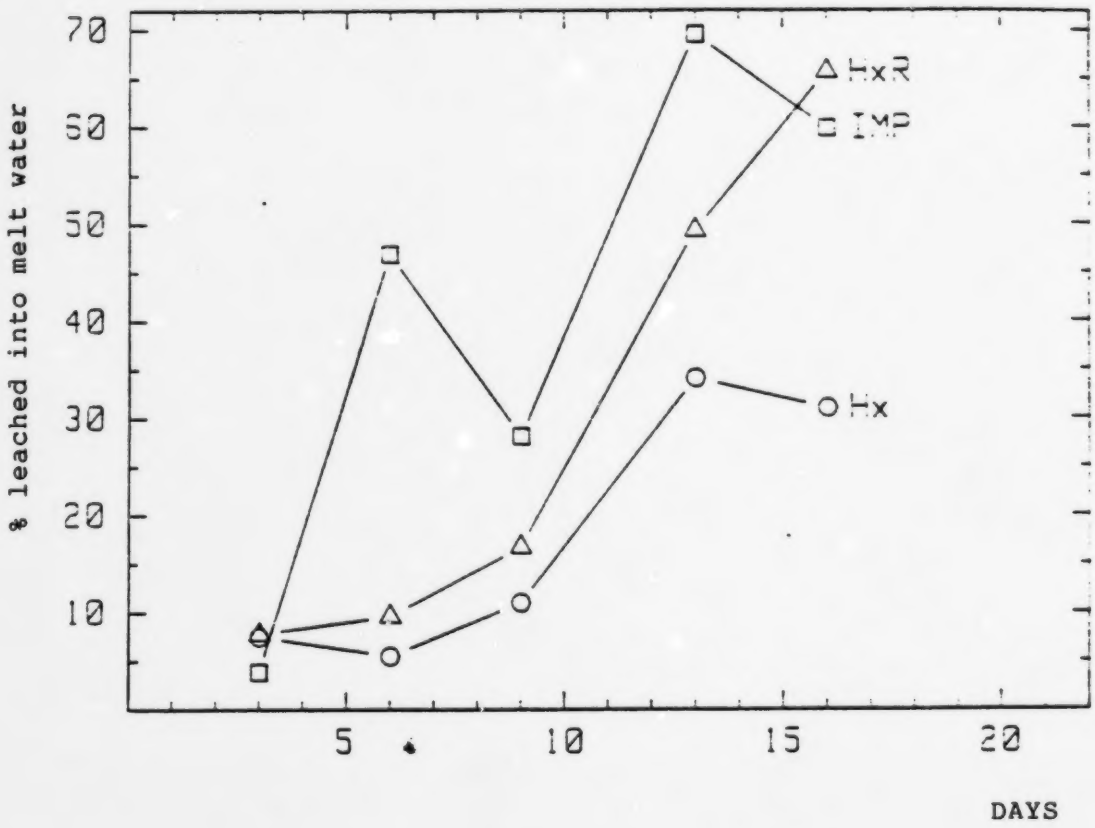

Fig. 8. Percentage of hypoxanthine, inosine and inosine-monophosphate found in melt water from gutted and deheaded coalfish, stored in ice at +25 degrees C.

Only a minor amount of volatile nitrogen compounds will leach into the melt water from fish stored in ice at low temperatures. If the fish is stored at high temperatures, the amount of volatile nitrogen compounds that leach into the melt water may be of importance when determining the quality of the fish through chemical analysis.

LITERATURE

Bullard, F. A. and Collins, J. (1980):
An improved method to analyze trimethylamine in fish and the interference of ammonium and dimethylamine.
Fishing Bulletin, no. 78 (2), pp 465.

Conway, R. I. and Byrne, A. (1933):
An absorption apparatus for the microdetermination of certain volatile substances.
Biochemistry Journal, no. 27, pp 419-429.

Dowden, H. C. (1938):
The determination of small amounts of dimethylamine in biological fluids.
Biochem. J., no. 32, pp 455-459.

Tertnes, G. Losnegard, N. and Langmyhr, E. (1982-83):
An analysis of the quality of fish stored in refrigerated sea water and in ice, II - IV.
The Fisheries Directorate, Reports and Announcements, No. 6/82, No. 8/83, No. 9/83.

A P P E N D I X 1

Results of analyses -

whole coalfish stored in ice at +3 degrees C

Results of analyses - whole coalfish stored in ice at +3 degrees C.*

TMAO, volatile nitrogen compounds, hypoxanthine (Hx), inosine (HxR) and inosinemonophosphate (IMP) in whole coalfish stored in ice at +3 degrees C.

Tot. volat. N Fillet

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	52,9	8,1	0,29	0,07	5,6	11,5	144,2
1	50,8	10,2	0,34	0,09	4,6	16,1	278,4
3	37,5	9,4	0,53	0,19	6,9	48,3	249,4
6	34,5	11,1	0,92	1,04	9,1	69,4	85,4
9	37,1	13,9	1,89	1,06	23,6	120,6	32,6
13	30,6	17,2	2,26	6,03	11,0	46,7	7,9
16	27,4	19,4	10,82	7,21	27,5	84,2	15,3

Waste matter

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	21,2	4,1	0,44	0,14	8,8	9,6	69,0
1	17,5	5,3	0,57	0,30	20,3	16,7	89,5
3	17,8	7,4	0,76	0,98	16,3	28,7	71,3
6	15,7	11,6	1,41	2,27	15,1	28,1	20,8
9	13,7	16,8	3,12	5,08	22,6	38,3	4,4
13	10,1	23,7	5,28	10,46	15,1	21,6	4,4
16	6,3	31,0	7,41	12,36	33,5	31,6	7,9

* Transl. note: In these and following tables, decimal commas = decimal points in Engl. usage.

A P P E N D I X 2

Results of analyses -
blood-drained coalfish stored in ice at
+3 degrees C

Results of analyses - blood-drained coalfish stored in ice at +3 degrees C.

TMAO, volatile nitrogen compounds and hypoxanthine (Hx), inosine (HxR) and inosinemonophosphate (IMP) in blood-drained coalfish stored in ice at +3 degrees C.

Tot. volatile N Fillet

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	54,2	8,0	0,31	0,11	4,7	11,8	115,1
1	51,8	11,2	0,42	0,15	4,3	15,7	273,5
3	55,4	13,1	0,55	0,55	7,7	38,7	293,3
6	47,8	11,9	0,97	1,10	10,1	67,7	106,1
9	34,9	14,6	2,1	1,55	28,1	117,9	20,7
13	31,7	18,8	2,24	5,50	12,2	46,1	5,2
16	27,2	27,2	8,98	10,18	31,0	6,0	15,0

Waste matter

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	21,0	4,0	0,63	0,20	13,7	12,9	97,3
1	19,2	6,3	0,63	0,43	17,6	14,9	86,2
3	15,9	10,3	0,85	1,58	14,5	25,1	75,0
6	16,8	12,1	1,41	3,16	21,8	37,9	27,5
9	17,3	20,0	3,35	4,68	32,9	45,7	15,6
13	9,6	27,5	5,96	8,72	16,8	24,2	5,4
16	1,7	38,6	11,72	10,71	36,6	26,7	3,7

A P P E N D I X 3

Results of analyses - gutted, deheaded coalfish stored in ice at +3 degrees C

Results of analyses - gutted, deheaded coalfish stored in ice at +3 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine (Hx), inosine (HxR) and inosinemonophosphate (IMP) in gutted, deheaded coalfish stored in ice at +3 degrees C.

Fillet

Days	TMAO-N mg/100g	Tot. volatile N Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	53,3	6,2	0,29	0,08	7,3	19,0	206,4
1	49,3	10,4	0,40	0,16	7,0	19,5	305,0
3	52,0	9,6	0,49	0,39	6,1	32,8	212,9
6	46,8	10,7	0,71	1,23	11,6	90,3	57,8
9	41,0	9,8	1,24	1,95	22,4	122,7	33,1
13	34,6	18,1	4,12	4,11	15,5	44,4	4,3
16	24,8	25,4	13,99	6,40	16,1	37,4	8,0

Waste matter

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	30,9	3,7	0,39	0,22	17,4	16,3	98,7
1	22,3	5,9	0,64	0,81	13,0	17,7	88,6
3	26,8	7,5	0,74	0,99	18,8	35,3	58,0
6	25,1	11,0	0,92	3,56	20,1	66,5	2,0
9	32,0	14,5	1,99	4,95	39,5	94,3	17,1
13	19,2	20,3	6,67	7,00	16,3	24,2	4,7
16	1,1	27,6	16,51	6,02	51,7	35,9	16,2

A P P E N D I X 4

Results of analyses - gutted, deheaded coalfish stored in ice at +25 degrees C.

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Results of analyses - gutted, deheaded coalfish stored in ice at +25 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine (Hx), inosine (HxR) and inosinemonophosphate (IMP) in gutted, deheaded coalfish stored in ice at at +25 degrees C.

Fillet

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	53,5	6,2	0,29	0,08	7,3	19,0	206,4
1	50,5	3,2	0,40	0,12	7,9	19,5	275,6
3	41,7	8,5	1,16	0,14	4,8	32,8	176,8
6	49,7	11,5	0,90	0,98	12,6	90,3	2,2
9	26,6	18,9	7,38	1,78	34,6	122,7	17,3
13	14,2	23,6	12,71	6,06	15,6	44,4	3,1
16	8,6	33,4	17,34	9,69	19,8	37,4	3,0

Waste matter

Days	TMAO-N mg/100g	Tot.fl.N mg/100g	TMA-N mg/100g	DMA-N mg/100g	Hx mg/100g	HxR mg/100g	IMP mg/100g
0	30,9	3,7	0,39	0,22	17,4	16,3	98,7
1	24,7	7,5	0,52	0,63	10,0	16,1	81,9
3	28,3	8,3	0,51	1,57	14,6	51,7	50,4
6	26,8	10,2	1,19	2,95	28,0	54,2	10,9
9	13,4	22,5	12,53	5,64	53,6	31,3	6,5
13	6,7	27,6	3,65	5,55	16,4	15,7	2,5
16	0	36,8	15,38	5,66	42,0	12,6	6,4

A P P E N D I X 5

Results of analyses - melt water from whole coalfish stored in ice at +3 degrees C

Results of analyses - melt water from whole coalfish stored in ice at +3 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine, inosine and inosinemonophosphate in melt water from whole coalfish stored at +3 degrees C.

Days	TMAO-N mg/l	Tot. volatile Melt water Tot.fl.N^{N} mg/l	TMA-N mg/l	DMA-N mg/l	Hx mg/l	HxR mg/l	IMP mg/l
1	0	3,0	1,29	1,03	6,9	57,5	0
3	0	13,6	1,42	1,48	10,8	45,0	0
6	13,9	15,9	2,89	2,92	16,4	46,9	0
9	23,3	36,0	7,96	6,15	33,9	63,9	0
13	0	66,5	29,6	14,50	31,4	0	0
16	0	163,4	50,0	29,94	47,5	62,2	0

A P P E N D I X 6

Results of analyses - melt water
from blood-drained coalfish
stored in ice at +3 degrees C

Results of analyses - melt water from blood-drained coalfish stored in ice at +3 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine, inosine and inosinemonophosphate in melt water from blood-drained coalfish stored in ice at +3 degrees C.

		Tot. volatile N	Melt water				
Days	TMAO-N mg/l	Tot.fl.N mg/l	TMA-N mg/l	DMA-N mg/l	Hx mg/l	HxR mg/l	IMP mg/l
1	0	5,5	1,31	1,45	9,2	55,0	7,8
3	6,6	14,6	1,55	2,26	13,6	43,1	0
6	3,3	18,8	3,09	3,85	18,1	47,6	0
9	19,8	49,8	7,56	7,99	44,7	111,9	50,3
13	33,5	41,7	14,6	14,25	25,6	60,3	0
16	0	187,6	61,2	36,99	65,6	70,3	0

A P P E N D I X 7

Results of analyses - melt water from gutted and deheaded coalfish stored in ice at +3 degrees C.

Results of analyses of melt water from gutted and deheaded coalfish stored in ice at +3 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine, inosine and inosinemonophosphate in melt water from gutted and deheaded coalfish stored in ice at +3 degrees C.

Melt water

Days	TMAO-N mg/l	Tot. volatile N Tot.fl.N mg/l	TMA-N mg/l	DMA-N mg/l	Hx mg/l	HxR mg/l	IMP mg/l
1	0	3,2	1,33	1,16	7,5	61,4	0
3	30,8	21,9	1,68	2,41	21,1	98,9	61,7
6	18,1	19,4	3,09	3,78	30,6	89,4	10,8
9	19,4	29,7	5,80	4,08	47,8	115,0	0
13	5,1	92,8	27,8	31,55	58,6	58,6	15,8
16	0	102,8	69,4	26,04	42,5	57,2	0

A P P E N D I X 8

Results of analyses - melt water from gutted and deheaded coalfish stored in ice at +25 degrees C

Results of analyses - melt water from gutted and deheaded coalfish stored in ice at +25 degrees C.

TMAO, volatile nitrogen compounds, hypoxanthine, inosine and inosinemonophosphate in melt water from gutted and deheaded coalfish stored at +25 degrees C.

Days	Tot. volatile N	Melt water				
	TMAO-N mg/l	Tot.fl.N mg/l	TMA-N mg/l	DMA-N mg/l	Hx mg/l	HxR mg/l	IMP mg/l
1	0	3,2	1,34	0,57	-	-	-
3	2,0	7,2	1,33	0,90	12,5	71,1	86,9
6	3,3	4,9	3,99	0,90	12,8	43,3	0
9	0,4	44,5	23,37	1,69	33,6	51,1	0
13	0	55,4	16,9	14,25	17,2	35,0	7,8
16	0	93,8	78,6	12,68	31,7	80,8	0